Date: 24th June 2021
Our Ref No.: TJ/UT1/OUT-01

To,
Doosan Heavy Industries & Construction Co., Ltd.
Mr. Youngsoo Son– Project Manager
465 Gangnam-daero, Seocho-gu, Seoul, Korea (06611)

Contract Reference: Engineering, Procurement and Construction Contract between Nepal Water And Energy Development Company Private Limited (NWEDC) and Dooshan Heavy Industries & Construction Co. Ltd for the Engineering, Procurement and Construction (EPC) for the 216 MW Hydropower Plant at Upper Trishuli -1, Nepal

Subject: Submission of Review Notes on Method Statement for Test Blasting and Excavation and Initial Support Drawings of Adit No.3

References:

1. Document No. UT1-C-000-CVL-MS-80032 dated 8th June 2021
2. Document No. UT1-HEP-DHI-D-0016 dated 9th June 2021

Dear Sir,

With reference to references no. 1 and 2 dated 08th and 9th June 2021, regarding Method Statement for Test Blasting and Excavation & Initial Support Drawings of Adit No.3 respectively.

We have reviewed the above-mentioned documents and listed our comments. Please find our comments in the Review Notes (RN-001 and RN-002) enclosed herewith the letter.

We hereby request you to resubmit the said documents incorporating all the comments.

Sincerely,

.....
Mr. Carsten GUNTERMANN
Project Manager (CRE)

Tractebel TRACTEBEL ENGIE Engineering GmbH

Enclosure:
1. Review Note (RN-001)
2. Review Note (RN-002)

UPPER TRISHULI-1 HEP (216MW)

Client	**Nepal Water and Energy Development Company Private Limited**
Owner's Engineer (OE)	**Tractebel Engineering GmbH / Jade Consult**

REVIEW NOTE

Contractor	**Doosan Heavy Industries & Construction Co., Ltd.**		
Title of the Document	Excavation and Initial Support Drawings of Adit No. 3		
Document No.	UT1-C-150-CVL-DG-43004 (Sheet 1 to 4)	Revision	00
Date of Documents	09.06.2021	Received Date	09.06.2021
Transmittal Form No.	UT1-HEP-DHI-D-00016		
Previous Review Date/Status	N/A	Prev. Review Note No.	N/A
Review Note No.	**RN-002**	**Present Review Date**	**22.06.2021**
		Present Review Status	**RR**

A: Approved AC: Approved with Comments RR: Returned for Resubmission

General Comments

1. The Contractor submitted rock support drawings for Adit No. 3, illustrating rock support measures for different support classes. In line with this, the Contractor is requested to submit necessary supporting documentation for the design of tunnel supports (i.e. calculations which prove the suitability and appropriateness of the suggested support strategy).
2. The Contractor intends to apply 6 different support classes (I, II, IIIa, IIIb, IV and V). However, the distribution of support classes with respect to rock-mass quality is not clear. As standard process, support classes are linked to a rock mass classification system (RMR, Q, etc.). The Contractor is requested to provide all baseline parameters on which the site geologist/tunnel engineer will decide on the application of suitable support class.
3. The Contractor is requested to provide a Method Statement for Tunnel Excavation which is applicable for the excavation of all tunnels in the project. The Method Statement shall contain information regarding (i) equipment, (ii) personnel, (iii) procedures (used rock-mass classification system, procedures regarding the application of support measures, details regarding the sequence of excavation & support installation, etc.), and (iv) health & safety plan.
4. The Contractor is requested to submit the overall layout of Adit No. 3 location including the chainage where Adit No.3 meets the Headrace Tunnel.

Drawing UT1-C-150-CVL-DG-43004 Sheet 1 of 4

5. Note No. 1 mentions that the set of drawings refers to the "*initial support*". The Contractor is requested to clarify and explain what is understood as "initial support".
6. Note No. 3 refers to "*a loose block which has a major influence on the slope stability*". Further details of the slope conditions in the portal area are missing. Contractor is requested to carry out a slope status assessment with the input of an Engineering Geologist, and submit respective supporting documentation.
7. Note No. 6 mentions that the span at tunnel intersections and "*turning adit*" (passing bays) is large. Intersections and niches constitute require support modifications based on their geometrical features (i.e. span, type of junction, and stretch length). Rock support measures shall adapt to these enlarged

sections (i.e. longer bolts due to larger span, modified bolt patterns, shotcrete thickness, etc.). Hence, Contractor is requested to provide information regarding specific support measures for tunnel intersections and passing bays (niches).

Drawing UT1-C-150-CVL-DG-43004 Sheet 2 of 4

8. Sheet 2 of 4 shows a detail (Detail A) regarding the slope support above tunnel portal. As mentioned before, further information (i.e. overburden, rock line, major joint sets, loose blocks, etc.) regarding the geological conditions of the portal slope shall be provided in order to assess the suitability of the suggested support measures.

9. Detail A also shows a drainage ditch at the top of the protected slope area. Will the drainage ditch excavation in rock or soil? Is there any pavement foreseen (e.g. shotcrete, concrete, stone masonry) for this drainage ditch?

10. Note No. 2 indicates that shotcrete with "*cylinder strength of only 21 MPa (28 days)*" will be applied. Contractor is requested to submit a list of approved shotcrete mixes for the project. Moreover, a shotcrete strength of only 21 MPa is considered as rather low for underground works. For underground works, and especially when it comes to permanent support, it is rather common to apply at least C30, with a cylinder strength of 30 MPa (28 days).

11. Note 4 describes that concrete class E refers to a cylinder strength of 24 MPa (28 days). Contractor is requested to submit a list of approved concrete mixes for the Project.

Drawing UT1-C-150-CVL-DG-43004 Sheet 3 of 4

12. Sheet 3 of 4 provides details of the rock dowels. The diameter of the rock dowel and the diameter of the borehole should be indicated in these details, as well.

Drawing UT1-C-150-CVL-DG-43004 Sheet 4 of 4

13. As already mentioned, the rock-support baseline criteria are not clear. Contractor shall relate proposed support measures to a rock-mass classification system, for each support class.

14. The Contractor obviously intends to apply plastic fibres as reinforcement for the shotcrete. It is strongly recommended to use steel fibres, instead. Typically, steel fibres are globally used as reinforcement for shotcrete. Shotcrete reinforced with steel fibres in comparison to plastic fibres provides higher compressive strength (peak/residual), as well as flexural strength. Therefore, it is considered as first choice for the support of underground structures.

15. Contractor is requested to provide information regarding steel fibre content of the shotcrete.

16. The sections indicate an invert slab for each support class. Contractor is requested to provide information regarding the material foreseen for the invert slab.

17. Sections for Rock Class IV and V and the section for forepolling indicate "*concrete*" as inner lining additionally to the shotcrete. The Contractor is requested to provide further details regarding the purpose and properties of the proposed "*concrete*" (e.g. concrete strength, reinforcement if required, etc.). Furthermore, the Contractor is requested to clarify the method of application (i.e. cast in place concrete with formwork or shotcrete).

DISCLAIMER

Any approval will not release the Contractor from any of his obligations under the Contract.

Karsten Thermann	Renos Christakis
(Signature)	(Signature)